

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.

BULLETIN 44.
THE CLIMATE OF SAN FRANCISCO.

Prepared under the direction of WILLIS L. MOORE, Chief U. S. Weather Bureau,

BY

ALEXANDER G. McADIE,
PROFESSOR OF METEOROLOGY.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1913.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU.

BULLETIN 44.
THE CLIMATE OF SAN FRANCISCO.

Prepared under the direction of WILLIS L. MOORE, Chief U. S. Weather Bureau,

BY

ALEXANDER G. McADIE,
PROFESSOR OF METEOROLOGY.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1913.

This publication may be procured from the Superintendent of Documents,
Government Printing Office, Washington, D. C., at 5 cents per copy.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU, OFFICE OF THE CHIEF,
Washington, D. C., December 3, 1912.

The honorable the SECRETARY OF AGRICULTURE.

SIR: I have the honor to transmit herewith a paper by Prof. A. G. McAdie, of the Weather Bureau, on the "Climate of San Francisco," and to recommend its publication as a Weather Bureau Bulletin, the edition to be 5,000 copies.

Very respectfully, your obedient servant,

WILLIS L. MOORE,
Chief United States Weather Bureau.

Approved.

JAMES WILSON,
Secretary.

THE CLIMATE OF SAN FRANCISCO.

INTRODUCTION.

San Francisco is in latitude $37^{\circ} 48' N.$, longitude $122^{\circ} 23' W.$ from Greenwich. The declination at the present epoch is $18^{\circ} E.$ and the dip $62^{\circ} 12'.$ The difference in time between San Francisco, Washington, and Greenwich is as follows:

San Francisco.	Washington.	Greenwich (mean civil time).
12 noon.....	15 hours (3 p. m.).	20 hours (8 p. m.)

When it is noon at San Francisco it is 9.29 a. m. at Honolulu; 3.37 a. m. of the next date at Hongkong; 4.04 a. m. at Manila, and 5.19 a. m. at Yokohama.

In standard time, San Francisco is 3 hours earlier than New York, 2 hours earlier than Chicago, and 1 hour earlier than Salt Lake City. There is a difference of 9 minutes and 32 seconds between mean local time at San Francisco and one hundred and twentieth meridian time, the latter being the time in common use.

The city is built on the northern end of a peninsula and, except on the southern side, is surrounded by water. The Golden Gate is the water passage connecting the Bay of San Francisco with the Pacific Ocean, and it forms the northern boundary of the city. The Bay of San Francisco, extending north and south at an average distance from the ocean of 7 miles, bounds the city on the east. The bay, including its northern extension, San Pablo Bay, has an area of 420 square miles, and the length of the shore line is approximately 100 miles. The depth of the water varies from 2 to 69 fathoms. The eastern boundary of the bay, known as the Contra Costa and Alameda shores, is for the most part low lying, the land rising gradually for a distance of a mile or more and then abruptly forming the Berkeley Hills. Farther east Mount Diablo rises to a height of 3,849 feet, the summit of which can be plainly seen from the hills of the city, although distant 32 miles.

In the bay there are many islands, the most prominent being Angel Island, Yerba Buena, and Alcatraz.

The northern shore line is rugged and the land rises abruptly from the water. The Sausalito Hills have an average elevation of 110 meters (360 feet), and back of these Mount Tamalpais, 14 miles distant from the city in an air line, reaches an elevation of 792 meters (2,596 feet).

San Francisco covers an area of 46.5 square miles. Within the city limits are numerous hills, varying in elevation from 46 meters (150 feet) to 286 meters (938 feet). The highest elevation is Mount Davidson, 938 feet; followed closely by Mount Sutro, formerly known as Blue Mountain, 920 feet; the South Twin, 919 feet, and the North Twin, 919 feet.

HISTORY OF THE RECORDS.

Thomas Tennent, Dr. G. H. Gibbons, Dr. T. M. Logan and Mr. John Pettee kept records of rainfall and temperature for many years, and through their labors it has become possible to compile tables of these data covering a period of 63 consecutive years, the record beginning September 1, 1849. The thermometers used were of the self-registering pattern and were exposed on the north side of building on supports 10 inches distant from the wall and 6 feet above the ground. The instruments were at a later date compared with Weather Bureau instruments and found to be approximately accurate. The rainfall records obtained by Mr. Tennent at the foot of Market Street cover a period of 22 years, from September, 1849, to December, 1871. A 3-inch gauge of the type known for many years as the Tennent gauge was used. The catch of this gauge was carefully compared with the catch of the 8-inch Weather Bureau gauge and the differences were found to be small. Official records began when the Signal Service Office was established in the old Merchants Exchange Building, the first observation being made February 2, 1871. The office was moved to the Phelan Building September 4, 1890, and to the Mills Building November 1, 1893. After the earthquake and fire of April 18, 1906, the office was reestablished in the new Merchants Exchange Building, now known as the Chamber of Commerce. From April 19 until September 30, 1906, observations of temperature and rainfall, pressure, wind direction, and sunshine were made at No. 3014 Clay Street.

The instruments are now exposed on the roof of the 14-story building at No. 431 California Street. The portion of the roof in use has a width of 122 feet and a depth of 62 feet. The anemometer cups are 204 feet above the street; the rain gauge is 191 feet and the instrument shelter 198 feet above the street.

The station elevation of the barometer is 147.3 feet above the reference plane or city base, which in turn is 8 feet above mean sea level. The actual elevation of the barometer is 207.5 feet above sea level or 52.2 feet higher than the level used as a station elevation.

Extra instruments are exposed on the floor of the Chamber of Commerce and in addition a continuous record of the outside, or street temperature, is obtained. There is also a kiosk in Union Square Park, near the corner of Stockton and Post Streets, with instruments for recording temperature, rainfall, percentage of saturation, and pressure.

CONTROLLING FACTORS OF THE CLIMATE.

A clearer understanding of the problems connected with the weather of San Francisco can be had by considering the general topography of the section, rather than that of the city itself. The entire district is one of marked contrasts in air drainage. Strong surface currents of air will at times flow in from the sea through the Gate toward the Great Valley, while at other times these currents will be reversed in direction. The factor that exerts the greatest influence in controlling the weather of the San Francisco Bay section is the proximity of the ocean. The factor of next importance is the prevailing drift of the surface air from sea to land during summer months and from land to sea during winter months. A third factor is the diversified topography favorable on the whole for local circulation and consequently so-called local climates. A fourth factor is the general pressure distribution over the northwestern portion of the continent and the North Pacific Ocean. In a normal winter the Aleutian low extends from latitude 40° N. to 60° N. and from longitude 130° W. to 140° E. Variations in the position and intensity of this low are found to bear definite relation to the amount and frequency of rain. During summer months the Aleutian low practically disappears. The continental high and also the Pacific high play important rôles in connection with the strong northwest winds of summer on the California coast. For a discussion of the general relations between wet and dry seasons and the displacements of pressure areas or centers of atmospheric action, the reader is referred to Bulletin L, "Climatology of California," or to the Monthly Weather Review, April, 1908, in an article entitled "Forecasting for the Pacific Coast."

STORM FREQUENCY.

Compared with other portions of the United States, the San Francisco Bay section has comparatively few storms. This is because most of the recognizable disturbances pass far north of this section. Except in winter very few low pressure areas move from the ocean across California, as nearly all the storms that enter the United States from the west pass far north of central California. Since 1850 there have been during the months of June, July, and August but 13 storms of the character mentioned above. During September, 14 such disturbances have been noted in the period of 63 years, and of these the most important was the storm of September 22-26, 1904. This storm is worthy of special mention as it stands unparalleled in the history of summer and early fall disturbances. In four days 5 inches of rain fell, whereas the normal rainfall for the whole month of September is 0.30 of an inch. The relative frequency of storms increases with the advent of winter. During October there have been 40 disturbances; during November 60; and during December,

January, and February about 200 per month for the total period of 63 years. Occasionally there will be a winter month without a single disturbance, as was the case in December, 1876, and February, 1864. March is a month of moderate frequency, April a month of occasional storms, and May of few storms.

PRESSURE.

The annual sea-level pressure at San Francisco as deduced from records covering a period of 38 years, 1873 to 1911 (1906 missing), is 30.027 inches. The lowest sea-level pressure recorded is 29.10 inches, which occurred February 22, 1891. The next lowest pressure, 29.23 inches, occurred March 10, 1904. The highest sea-level pressure, 30.60 inches, occurred December 23, 1905. The absolute range is 1.50 inches, and the mean annual range, 0.85 of an inch. The pressure is lowest during the summer months, averaging 29.92 inches, and highest in the winter months, averaging 30.10 inches. The daily pressure is lowest about 5.30 p. m., with a second minimum at 4 a. m., and highest at 10 a. m., with a second maximum at 11 p. m.

TEMPERATURE.

San Francisco has a comparatively small range of temperature. The annual mean, based upon records covering a period of 40 years, 1871 to 1911, and obtained from the mean of the daily maximum and minimum readings, is 13° C. (56° F.). A truer value determined from the 24-hourly readings for a period of 20 years, 1891 to 1910, is 12.6° C. (54.6° F.).

The departures from the mean are comparatively small in all months. The warmest month is September, with a mean of 15° C. (59.1° F.), and the coldest month, January, 9.6° C. (49.2° F.). The warmest month has practically the same departure above the mean as the coldest month has below. The annual amplitude is 5.5° C. (9.9° F.).

The monthly mean temperatures determined from hourly readings, 1891 to 1910, are:

Month.	Degrees centi- grade.	Degrees Fahren- heit.	Month.	Degrees centi- grade.	Degrees Fahren- heit.
January.....	9.6	49.2	July.....	13.6	56.4
February.....	10.7	51.3	August.....	13.9	57.0
March.....	11.1	52.1	September.....	15.0	59.1
April.....	12.1	53.8	October.....	14.7	58.5
May.....	13.1	55.7	November.....	12.9	55.2
June.....	13.5	56.3	December.....	10.1	50.2

The coldest month was January, 1890, when the mean temperature was 7.8° C. (46° F.), and the warmest month, September, 1889, when the mean was 18.3° C. (65° F.).

In an average year there are approximately 1,311 hours when the temperature is above 15.6° C. (60° F.); 4,111 hours when the tem-

perature is above 12.8° C. (55° F.); and 7,625 hours, or about 87 per cent of the entire year, when the temperature exceeds 10° C. (50° F.).

Differences between day and night temperatures are small. The warmest hour, 2 p. m., has a mean temperature of 15.1° C. (59.2° F.). The coolest hour, 6 a. m., has a mean temperature of 10.5° C. (50.9° F.).

The highest temperature ever recorded in San Francisco is 38.3° C. (101° F.). This occurred September 8, 1904, during a prolonged period of warm weather. For 4 consecutive days maximum temperatures exceeded 32.2° C. (90° F.). This was the warmest spell of which there is record in San Francisco. In the past 20 years there have been 27 days on which the temperature exceeded 32.2° C. (90° F.); but with the exception noted above there has been no period of 3 consecutive days when this temperature has been exceeded.

The lowest temperature recorded since 1871 is -1.7° C. (29° F.), which occurred January 15, 1888. In the last 20 years the temperature has not fallen below 0° C. (32° F.).

The following table gives the monthly and annual extremes of temperature, from 1871 to 1911, inclusive:

	Maximum.		Lowest maximum.		Minimum.		Highest minimum.	
	° C.	° F.	° C.	° F.	° C.	° F.	° C.	° F.
January.....	26	78	14	58	-1.7	29	8	46
February.....	27	80	16	60	.6	33	8	47
March.....	27	80	17	62	.6	33	10	50
April.....	31	88	17	63	2.0	36	9	49
May.....	36	97	21	70	6.0	42	10	50
June.....	38	100	19	67	8.0	46	12	53
July.....	37	98	19	66	8.0	47	12	54
August.....	33	92	20	69	8.0	46	12	54
September.....	38	101	20	69	8.0	47	12	53
October.....	34	94	22	72	7.0	45	12	53
November.....	28	83	18	64	3.0	38	10	50
December.....	22	72	15	59	1.0	34	7	44
All years.....	38	101	14	58	-1.7	29	12	54

The absolute range of temperature from 1871 to 1911 is 40° C. or 72° F.

SUNSHINE.

The amount of sunshine received at San Francisco is not as large as might be expected, but nevertheless compares favorably with that of other cities in the United States. The average number of hours in a year, based upon hourly records from 1894 to 1910, is 2,807, or 63 per cent of the possible. The average number of hours of sunshine for different months is:

	Hours.	Per cent of possible.		Hours.	Per cent of possible.
January.....	147	50	July.....	308	68
February.....	163	63	August.....	258	61
March.....	213	67	September.....	252	68
April.....	256	66	October.....	236	68
May.....	294	67	November.....	175	58
June.....	345	75	December.....	160	54

The following table, from the Report of the Chief of the Weather Bureau, 1910-11, gives the total hours of sunshine during the year 1910 at certain of the larger cities in the United States:

	Hours.	Per cent of possi- ble.		Hours.	Per cent of possi- ble.
Baltimore.....	2,838	63	New York.....	2,750	61
Boston.....	2,547	56	Philadelphia.....	2,545	57
Chicago.....	2,778	60	Pittsburgh.....	2,164	47
Cincinnati.....	2,668	58	St. Louis.....	2,530	56
Denver.....	3,232	72	San Francisco.....	3,019	66
Kansas City.....	2,946	66	Washington.....	2,659	59
New Orleans.....	3,151	71			

It is interesting to compare the number of hours of sunshine at Mount Tamalpais for a year with the number at San Francisco, 14 miles away. In 1910 the total number of hours of sunshine at Mount Tamalpais was 3,258, or 70 per cent of the possible; at San Francisco, 3,019 hours, or 66 per cent of the possible. The difference, amounting to 239 hours, equivalent to the total sunshine of an average month, shows how much sunshine is lost at San Francisco through the summer afternoon fog. The accompanying diagrams (figs. 7 & 8) illustrate the difference in sunshine at the lower and upper stations. In some years there is a difference of as much as 500 hours in the annual amounts of sunshine at the two stations. In some seasons the lower station receives more sunshine than the upper, the clouds forming and remaining on the mountain crest. The fogs can be seen to great advantage from the station at Mount Tamalpais. Many photographic studies of characteristic fog forms have been published in the Monthly Weather Review, the Climatology of California, and elsewhere. Some of the fogs are caused by the mixing of air streams of different temperatures and different vapor content. Some are caused by cooling due to elevation and some by excessive loss of heat by radiation. It is interesting to note that in some of the summer months San Francisco receives but 68 per cent of the possible sunshine, while at Mount Tamalpais more than 90 per cent is recorded.

THE WINDS.

The prevailing drift of the surface air along the California coast is from west to east. The charts of wind direction issued each month for the North Pacific show in detail the relative strength and frequency of the surface winds on the California coast. Briefly, the summer winds may be grouped as follows: West to northwest, 75 per cent; north to northeast, 4 per cent; east to southeast, 3 per cent; south to southwest, 3 per cent; and calms, 15 per cent. The winter

winds show a greater percentage of motion from the south. Southerly gales are not infrequent, and there is a common belief that southeast is the prevalent direction in winter months. This, however, is not true. West to northwest winds have a frequency of 30 per cent; north to northeast, 18 per cent; east to southeast, 17 per cent; south to southwest, 22 per cent; and calms, 13 per cent.

It is plain from the above figures that northwest is the predominant direction along the coast in the vicinity of San Francisco. Owing to the topography there are certain deflections and changes in the direction of the wind, especially through the Golden Gate from northwest to west or even west by south.

During certain portions of the year, especially May and June, the northwest wind attains a remarkably high velocity. In May, 1902, and May, 1903, memorable northwest gales occurred. The following table gives wind data as recorded at Point Reyes Light, California:

Two memorable northwest gales at Point Reyes Light, Cal.

Date.	Average velocity, miles per hour.				Daily movement.		Maximum velocity.	Extreme velocity.	Time of maximum velocity
	0 to 6 a. m.	6 a. m. to 12 noon.	12 noon to 6 p. m.	6 p. m. to 12 mid-night.	Total.	Average hourly.			
1902.									
May 13.....	7	4	11	10	<i>Miles.</i> 188	<i>Miles.</i> 8	<i>Miles.</i> 16	<i>Miles.</i> 16	.....
14.....	11	14	12	22	347	14	28	30	.....
15.....	29	31	31	36	756	31.5	45	50	.....
16.....	39	38	46	58	1,086	45	76	80	10.30 p. m.
17.....	64	54	67	78	1,580	66	90	96	7.00 p. m.
18.....	75	70	79	88	1,876	78	110	120	8.50 p. m.
19.....	59	45	59	64	1,360	57	75	80	7.00 p. m.
20.....	40	27	31	52	905	38	57	62	10.45 a. m.
21.....	34	12	11	22	474	20	48	50	12.50 a. m.
22.....	21	7	9	12	291	12	27	29	.....
23.....	17	7	10	15	287	12	26	30	.....
1903.									
May 13.....	13	9	11	35	410	17	48	50	10.15 p. m.
14.....	51	39	47	55	1,153	48	64	66	9.00 p. m.
15.....	43	44	63	78	1,371	57	89	93	7.55 p. m.
16.....	72	60	65	82	1,673	70	94	98	9.55 p. m.
17.....	62	42	51	67	1,339	56	89	92	12.05 a. m.
18.....	58	52	48	59	1,247	52	68	70	12.10 a. m.
19.....	45	45	47	50	1,124	47	60	62	12.15 a. m.
20.....	42	42	50	50	1,103	46	58	60	3.50 a. m.
21.....	47	47	53	57	1,227	51	64	66	8.45 a. m.
22.....	42	39	39	45	986	41	59	61	11.30 a. m.
23.....	47	19	18	30	679	28	52	54	12.45 a. m.

The following table gives comparative wind data for the gale of May, 1903; also the total movement for the month at five points in the vicinity of San Francisco. The table has especial interest because the grouping of the stations is such as to throw light on the movement of the air at the ocean level free from obstruction; at sea level near the entrance to the Gate; in the city itself on the roof of a high

building; on a headland 149 meters (490 feet), and on a mountain summit 721 meters (2,375 feet):

Stations.	Elevation.		Total for month.	Average daily.	Greatest in 24 hours.	Greatest hourly movement.
	<i>Meters.</i>	<i>Feet.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>	<i>Miles.</i>
Point Reyes Light.....	149	490	24,072	776	1,673	88
Mount Tamalpais.....	721	2,396	16,871	544	1,189	78
San Francisco.....	63	207	10,040	324	517	34
Point Lobos.....	76	250	15,431	498	929	60
S. E. Farallon Island.....	9	30	17,331	559	1,185	58

There is another class of high winds experienced at San Francisco, namely, the north-northeast winds of November, December, and occasionally January. These winds are different from the northwest winds of summer and are distinctly mountain winds. The highest wind velocity recorded in San Francisco, 64 miles from the northeast, occurred on November 30, 1906.

The most prevalent high wind of winter is from the southwest, closely followed by the southeast. The latter is the well-known wind preceding winter storms in this section. At San Francisco southeast winds will sometimes prevail for several days; but in most storms the wind after blowing for 12 or more hours increases in velocity to 40 miles an hour, more or less, and then shifts suddenly to the southwest, attaining a slightly higher velocity. After a few hours the velocity decreases and, with the change to northwest, the weather clears. At such times the air is remarkably pure and the distant mountains can be seen distinctly.

The average hourly wind velocity in San Francisco is nearly 10 miles and the prevailing direction west. The wind attains its greatest velocity about 4.30 p. m. and its least about 6 a. m. The average movement during the 12 hours from 7 a. m. to 6 p. m. is approximately 11 miles per hour and from 7 p. m. to 6 a. m. 9 miles per hour.

FOG.

One of the most marked climatic features of San Francisco is the prevalence of fog. In summer afternoons sea fog moves through the Gate, appearing about 1 p. m. and covering the whole sky by 3 p. m. The average depth of the fog layer is 518 meters (1,700 feet). Comparing the percentage of possible sunshine at San Francisco and Mount Tamalpais, it is at once apparent that the summer afternoon sea fog shuts out 50 per cent or more of the possible sunshine between 3 and 7 p. m. during June, July, and August. There is also curtailment of sunshine between 7 and 9 a. m. during May, June, July, August, and September.

In winter, morning fogs, or, as they are commonly called "tule" fogs, frequently occur. These are low-lying banks of condensed vapor formed by cooling due to radiation and contact. The land surfaces are much cooler than the water surfaces, and hence these fogs have a decided motion from the land to the sea. The average number of foggy days is 24 per year.

For a detailed description of fog phenomena in the vicinity of San Francisco the reader is referred to special articles in the Monthly Weather Review, the Climatology of California, and the Meteorological Charts of the North Pacific Ocean, 1911.

In addition to the summer afternoon sea fog, moving from west to east, and the land or tule fog of winter mornings, there is a third kind of fog which may be called smoke fog. Under certain atmospheric conditions the smoke of the city moves seaward during the forenoon and returns about 1 p. m. as a dense black pall. This is the cause of the so-called dark days. The phenomenon is of brief duration, seldom exceeding two hours; but while it lasts causes some apprehension.

HUMIDITY.

Relative humidity is a term frequently used in attempts to describe relative dampness of a locality. The term is misleading and while generally used can not give a proper basis for comparison unless temperatures are also given, inasmuch as relative humidity is only a ratio and does not indicate a fixed amount of water vapor. Thus at San Francisco relative humidity throughout the year is high; but during the summer months, owing to low temperatures, the absolute weight of water vapor per unit of volume and the vapor tension are much less than at coast stations of the Atlantic.

The following table shows mean vapor pressures and temperatures at San Francisco, New York, Chicago, and New Orleans:

San Francisco:	°F.
January...0.282 inch.....	49.5
July......384 inch.....	57.3
New York:	
January... .125 inch.....	30.2
July......588 inch.....	73.5
Chicago:	
January... .099 inch.....	23.7
July......548 inch.....	72.3
New Orleans:	
January... .316 inch.....	53.0
July......810 inch.....	81.3

This table explains why, notwithstanding high relative humidity in summer, the vapor tension and absolute humidity are low at San Francisco.

The highest relative humidity occurs in July, from 1 a. m. until 7 a. m., and equals or exceeds 95 per cent. The lowest relative humidity occurs in October, about 1 p. m., and is about 52 per cent. The vapor pressure is greatest in July, about 1 p. m., amounting to 0.410 inch. The vapor pressure is lowest in December, about 4 a. m., when it is less than 0.250 inch.

RAINFALL.

Rainfall records have been maintained in San Francisco for a period of 63 years. The greatest 24-hour rainfall occurred on January 28, 1881, when 4.67 inches fell. The next greatest 24-hour rainfall was on September 24, 1904, when 3.58 inches fell. A detailed statement of excessive rains will be found elsewhere. The longest rainless period was in 1903, when no rain fell from April 16 until October 9, 175 days. In 1911 there was no rain from June 6 to October 1, 116 days.

Some of the months of heaviest rain were: January, 1862, when 24.36 inches of rain fell, and 18 days of the month were rainy. In January, 1911, 13.79 inches fell, distributed over 18 days. In January, 1909, 10.51 inches fell, but there were 26 rainy days, making it in this sense the rainiest month known at San Francisco. In January, 1890, 9.61 inches fell, and there were 23 rainy days. In January, 1907, there were 21 rainy days, but the total rainfall amounted to only 4.41 inches, which is less than a normal rainfall, notwithstanding that the number of rainy days was nearly double the normal.

The rainiest February was in 1878, when 12.52 inches fell on 19 days. In February, 1887, 9.24 inches fell and there were 16 rainy days. In February, 1891, 7.26 inches fell and there were 19 rainy days; in February, 1902, 7.27 inches fell and there were 19 rainy days; in February, 1909, 7.53 inches fell and there were 18 rainy days.

The rainiest March was in 1879, when 8.75 inches fell and there were 14 rainy days; in 1907 the rainfall amounted to 8.42 inches and there were 20 rainy days; in 1904, the rainfall amounted to 6.01 inches and there were 23 rainy days; in 1884, 8.24 inches fell and there were 16 rainy days.

The rainiest April was in 1880, when 10.06 inches fell and there were 17 rainy days. The average number of rainy days in April is 6, and the average rainfall 1.64 inches.

From May until October, inclusive, there is little rain.

The rainiest November was in 1885, when 11.78 inches fell and there were 19 rainy days. The average number of rainy days in November is 7.

The rainiest December was in 1866, when 15.16 inches fell and there were 18 rainy days; in December, 1889, 13.81 inches fell and

there were 24 rainy days; in December, 1880, 12.33 inches fell and there were 19 rainy days.

Number of rainy days in the year.—In the past 62 years, 1850 to 1911, there have been 4,207 rainy days. The yearly distribution is: January, 11; February, 10; March, 11; April, 6; May, 4; June, 1; July, 0; August, 0; September, 2; October, 4; November, 7; December, 11. For the year, average number 67.

MONTHLY RAINFALL.

JANUARY.

From records covering a period of 63 years, 1850 to 1912, the mean January rainfall is 4.90 inches. The greatest rainfall was in 1862, when 24.36 inches fell and the least was in 1852, when 0.58 of an inch fell. There were 5 years in which the rainfall exceeded 10 inches and 3 years in which the rainfall did not exceed 1 inch. The largest number of rainy days, 23, occurred in 1890 and the smallest number in 1852, when there were 4 rainy days. The average number of rainy days is 11. There have been 16 Januarys when the number of rainy days equaled or exceeded 15. In January, 1859, there were 26 consecutive days of fair weather.

FEBRUARY.

The mean rainfall is 3.55 inches. Reduced to a 30-day normal, best obtained by eliminating the rainfall of leap years and adding twice the rainfall on the 14th, we have 3.81 inches. The average number of rainy days is 10. The heaviest February rainfall was 12.52 inches in 1878 and the least, no rain, in 1864. Rainfalls exceeding 10 inches occurred once, in 1878, and rainfalls of less than 1 inch occurred 13 times. The largest number of rainy days in any February was 19, which occurred in 1878, 1891, and 1902. There have been 11 Februarys when the number of rainy days did not exceed 5. The largest number of consecutive rainy days was 15, which occurred in 1891. The largest number of consecutive fair days was in February, 1864, when there were 29.

MARCH.

The mean rainfall is 3.36 inches. The greatest amount was in 1879, when 8.75 inches fell. The next rainiest March was in 1907, when 8.42 inches fell. The least was in 1898, when only 0.24 of an inch fell. There have been 12 years in which the rainfall for March equaled or exceeded 5 inches, and 8 in which the total monthly amount did not exceed 1 inch. In 1908 there were 18 consecutive days without rain, and in 1911, 21 days, with exception of a trace on one day. In 1900 there were 23 consecutive days during which

only a trace of rain fell. In 1875 there were 17 consecutive fair days, and in 1877, 21 consecutive fair days. In 1861 the month was without rain until the 23d. The average number of rainy days is 10. The largest number of rainy days in any month was in 1904 when there were 23, of which 19 were consecutive. The smallest number of rainy days was in 1901 when there were only 3. The heaviest 24-hour rainfall occurred on March 5, 1879, when 3.31 inches fell.

APRIL.

The mean rainfall is 1.64 inches. The month of heaviest rainfall was in 1880, when 10.06 inches were measured. There have been 6 Aprils out of the past 63 in which the rainfall equaled or exceeded 5 inches. There have been 27 in which the amount of rain did not exceed 1 inch. No rain fell in April, 1857, and there was only a trace of rain during April, 1909. The largest number of consecutive rainy days occurred in 1880, when it rained for 11 days. The average number of rainy days in April is 6. The greatest 24-hour rainfall was 2.43 inches on April 24, 1896.

MAY.

The mean rainfall for May is 0.73 of an inch. The rainiest May was in 1883, when 3.52 inches fell. There have been 5 Mays during the past 63 years when practically no rain fell. During 18 years the rainfall for May exceeded 1 inch. The average number of rainy days is 4. The greatest number of consecutive rainy days was 5, which occurred in 1860, 1889, and 1906. The largest number of rainy days in April was 11, in 1860 and 1883. The greatest 24-hour rainfall, 1.29 inches, occurred on May 5, 1889.

JUNE.

The mean rainfall for June for a period of 62 years is 0.16 of an inch. The month is practically rainless, only 3 times has the rainfall exceeded 1 inch. The heaviest June rainfall occurred in 1884, when 2.57 inches fell. The average number of rainy days is 2. In 1888 there were 9 rainy days. The heaviest 24-hour rainfall occurred on June 12, 1884, when 1.23 inches fell. Of the past 62 years 20 have been without rain during the month of June and 27 have had a rainfall not exceeding 0.01 of an inch.

JULY.

The mean rainfall for July is 0.02 of an inch. In the past 62 years there have been only 3 showers in which the total amount exceeded 0.05 of an inch. Most of the rainfalls did not exceed 0.01 of an inch. The greatest 24-hour rainfall was 0.23 of an inch on July 16, 1886.

AUGUST.

August, like July, is practically a rainless month. The mean rainfall is 0.02 of an inch. There has never been an August when the total rainfall exceeded 0.25 of an inch. Only 14 of the 62 months under consideration have had a rainfall exceeding 0.01 of an inch. The greatest 24-hour rainfall was 0.12 on August 26, 1858.

SEPTEMBER.

The mean rainfall is 0.30 of an inch. This, however, is larger than might be expected and is caused by phenomenal rainfall in September, 1904. In the 5 days, 22d to 26th, more than 5 inches of rain fell. The average number of rainy days is 2. The greatest number of consecutive rainy days is 5. There have been 19 Septembers without rain. Only once has the rainfall exceeded 5 inches and only 4 times has it exceeded 1 inch. The greatest 24-hour rainfall, 3.09 inches, occurred on September 23, 1904.

OCTOBER.

The mean rainfall is 1.02 inches. The heaviest rainfall was in 1889, when 7.28 inches fell. Other rainy Octobers were, 1899, 3.92 inches; 1876, 3.36 inches; and 1849, 3.14 inches. There have been 9 Octobers without rain. The average number of rainy days is 4, and the greatest number, 13, occurred in 1889. The heaviest 24-hour rainfall, 2.06 inches, occurred on October 21, 1858.

NOVEMBER.

The mean rainfall is 2.55 inches. The heaviest rainfall was in 1885, when 11.78 inches fell. Other rainy Novembers were, 1849, when 8.66 inches fell; 1859, when 7.28 inches fell. November, 1890, was without rain. The rainfall for November was less than 1 inch in 21 years. The average number of rainy days is 7. The greatest number of rainy days was 19 in 1885. The greatest 24-hour rainfall, 3.98 inches, fell on November 26, 1864, and again on November 23, 1874.

DECEMBER.

The mean rainfall is 4.56 inches. The heaviest rainfall was in 1866, when 15.16 inches fell. Other rainy Decembers were, 1852, 13.20 inches; 1871, 14.36 inches; 1880, 12.33 inches; 1889, 13.81 inches, and 1894, 9.01 inches. December, 1876, was rainless. Less than an inch of rain fell in 1854, 1865, 1874, 1878, 1883, and 1901. The average number of rainy days is 11. The greatest number, 24, was in 1889. The greatest 24-hour rainfall, 4.28 inches, fell on the 19th, 1866.

In connection with the absence of rain during December, 1876, it may be noted that there was no rain between November 16, 1876, and January 16, 1877. Or, in other words, there was a period of 60 consecutive days without rain in midwinter.

THUNDERSTORMS.

Few thunderstorms occur at San Francisco. In the past 20 years there have been 28, but not a single one that could be considered as severe. The following table shows the distribution: January, 2; February, 3; March, 1; April, 3; May, 1; June, 1; July, 1; August, 2; September, 2; October, 3; November, 3; and December, 6. The greatest number recorded in any one year was 8, in 1906. During the past 20 years there have been 8 years without record of a thunderstorm. The storms are mild in character, the lightning flashes of moderate intensity, and the thunder usually limited to a few peals. Damage from lightning is practically unknown, although some flagpoles have been shattered and one or two trees struck in the past 60 years.

HAIL.

There have been 56 hailstorms in the past 20 years. January and December are the months of maximum frequency. There is no record of any hailstorm occurring during June, July, August, and September.

SNOWSTORMS.

Snow is of rare occurrence. During winter storms the tops of the hills in the southwestern portion of the city are occasionally whitened by snowflakes. These melt rapidly and snow of appreciable depth is rare. However, snow can be seen frequently during winter months on Mount Tamalpais, Mount Diablo, and the peaks of the Mount Hamilton Range. The heaviest snowfall in the Bay Section occurred January 9, 1913, when Mount Tamalpais and Angel Island were covered.

DATES OF SNOWFALL AT SAN FRANCISCO SINCE MARCH 1, 1871.

January 21, 1876.—Light snow fell for ten minutes.

December 31, 1882.—Heavy snow fell from 11.30 a. m. to 4.20 p. m., amount 3.5 inches.

February 6, 1883.—A few flakes of snow fell during the day.

February 7, 1884.—Snow fell at intervals during the day, depth varying from 1 to 2 inches.

February 5, 1887.—Snow fell during the day; depth at office 3.7 inches, while in the western portion of the city it was fully 7 inches deep.

January 4, 1888.—A few flakes of snow fell during the day.

January 16, 1888.—Light snow fell to the depth of 0.1 inch.

March 2, 1894.—A few flakes of snow fell during the day.

March 2, 1896.—Snow mixed with rain fell at intervals during the day.

March 3, 1896.—Heavy snow fell during the night; depth at office at 8 a. m. 0.5 inch.

February 3, 1903.—Snow, large flakes, 11.16 to 11.20 a. m.

March 5-6, 1908.—Trace of snow fell.

February 26 and 27, 1911.—0.04 of an inch of snow fell.

January 9, 1913.—Light snow fell, which melted quickly.

TABLE 1.—*Annual sea-level pressure at San Francisco.*

Year.	Inches.	Year.	Inches.	Year.	Inches.
1873.....	30.027	1886.....	30.026	1899.....	30.053
1874.....	30.018	1887.....	30.023	1900.....	30.043
1875.....	30.024	1888.....	29.998	1901.....	30.050
1876.....	30.004	1889.....	29.998	1902.....	29.939
1877.....	29.992	1890.....	30.035	1903.....	30.058
1878.....	29.968	1891.....	30.036	1904.....	30.060
1879.....	30.017	1892.....	30.032	1905.....	30.025
1880.....	30.031	1893.....	30.055	1906.....	30.024
1881.....	30.028	1894.....	30.058	1907.....	30.038
1882.....	30.045	1895.....	30.043	1908.....	30.019
1883.....	30.039	1896.....	30.041	1909.....	30.054
1884.....	29.985	1897.....	30.055	1910.....	30.033
1885.....	30.012	1898.....	30.047	1911.....	30.033

Mean of 38 years, 30.027 inches.

TABLE 2.

This table gives the highest temperature for each month from 1871 to 1912, as given by self-registering mercurial thermometer.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Absolute annual maximum.
1871.....			74	69	76	77	66	69	78	84	78	62	84
1872.....	61	64	64	71	81	92	70	77	82	80	67	62	92
1873.....	66	64	73	75	75	67	74	72	69	79	72	59	79
1874.....	61	62	62	72	83	82	73	71	89	78	69	62	89
1875.....	62	63	67	81	71	79	71	70	82	79	68	65	82
1876.....	58	67	70	75	81	93	76	78	86	72	70	64	93
1877.....	69	67	73	64	75	92	76	75	92	81	69	64	92
1878.....	62	65	66	70	78	73	73	73	78	78	68	68	78
1879.....	62	70	77	76	75	85	76	89	86	81	65	64	89
1880.....	60	62	66	69	84	82	73	73	79	78	75	61	84
1881.....	63	69	76	76	75	71	83	70	80	72	66	63	83
1882.....	60	61	73	74	74	68	73	69	83	76	64	65	83
1883.....	60	70	74	63	86	95	80	82	91	74	67	62	95
1884.....	58	71	68	68	80	71	83	75	73	76	70	64	83
1885.....	62	69	76	75	77	67	78	81	87	76	70	67	87
1886.....	68	71	73	79	86	83	78	85	94	79	75	66	94
1887.....	73	67	78	78	97	90	70	74	89	87	74	69	97
1888.....	63	76	74	88	81	80	93	85	88	87	74	65	93
1889.....	64	75	79	77	88	75	83	80	89	87	77	63	89
1890.....	59	64	70	81	85	81	80	85	81	86	78	60	86
1891.....	72	63	76	81	75	100	81	92	86	85	78	64	100
1892.....	66	66	80	68	90	73	90	92	88	79	78	64	92
1893.....	60	69	78	72	74	90	74	72	72	74	74	72	90
1894.....	58	62	66	82	72	69	76	91	94	89	79	61	94
1895.....	63	69	70	73	89	86	83	80	89	83	83	60	89
1896.....	63	72	72	66	91	79	72	72	81	85	66	64	91
1897.....	60	66	63	84	88	83	82	70	92	85	68	63	92
1898.....	59	70	74	87	63	89	88	72	80	81	78	66	89
1899.....	78	80	74	80	80	75	73	78	73	94	65	63	94
1900.....	64	68	71	69	71	74	73	82	92	83	79	63	92
1901.....	62	75	78	72	81	82	75	72	78	91	75	72	91
1902.....	58	65	68	78	70	73	77	82	83	77	67	62	83
1903.....	59	66	64	71	77	96	91	77	92	85	67	66	96
1904.....	65	60	66	84	86	90	73	75	101	79	74	61	101
1905.....	63	71	79	71	85	67	98	73	87	84	74	67	98
1906.....	68	71	74	76	72	82	82	76	82	86	77	61	86
1907.....	61	68	69	81	80	85	78	74	78	90	78	68	90
1908.....	64	65	76	85	79	86	77	80	89	82	74	61	89
1909.....	60	62	67	80	80	94	77	82	93	86	74	63	94
1910.....	59	64	77	87	90	74	76	79	82	89	76	68	90
1911.....	72	67	79	73	85	77	84	79	82	87	77	71	87
1912.....	65	68	67	66	87	93	71	77	94	81	.....	.....	.....

TABLE 3.

This table gives the lowest temperature for each month from 1871 to 1912, as given by self-registering alcohol thermometer.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Absolute annual minimum.
1871.....			45	45	46	48	50	51	53	51	45	42	42
1872.....	43	47	48	43	48	52	52	53	52	48	44	41	41
1873.....	46	40	45	43	48	50	52	54	53	49	47	44	40
1874.....	39	43	42	47	50	48	49	51	50	50	44	40	39
1875.....	39	43	42	40	49	49	52	50	52	51	49	39	39
1876.....	36	41	41	44	45	49	51	51	52	52	50	42	36
1877.....	42	46	47	46	48	51	53	52	51	49	49	42	42
1878.....	39	45	46	44	48	51	51	52	52	51	47	40	39
1879.....	40	44	47	46	45	49	51	50	52	49	45	34	34
1880.....	37	38	39	42	45	49	52	51	50	50	41	42	37
1881.....	44	45	40	48	49	50	49	52	50	45	44	43	40
1882.....	40	38	41	44	45	49	52	50	50	48	45	34	34
1883.....	36	35	44	43	48	51	50	52	53	48	44	40	35
1884.....	43	35	45	45	49	52	52	52	52	50	50	40	35
1885.....	43	46	50	47	50	50	54	52	52	53	50	44	43
1886.....	41	41	41	44	48	48	50	48	50	46	45	43	41
1887.....	42	33	45	44	46	48	49	49	50	49	42	40	33
1888.....	29	42	38	46	47	53	51	51	50	50	47	43	29
1889.....	40	39	47	49	48	52	50	49	51	51	47	40	39
1890.....	36	36	41	46	47	49	49	50	52	48	46	39	36
1891.....	39	40	43	40	48	48	50	50	51	48	47	37	37
1892.....	40	42	42	44	47	47	50	50	51	47	42	38	38
1893.....	36	39	40	40	46	47	47	47	50	47	44	37	36
1894.....	36	38	37	42	44	47	48	49	49	49	46	40	36
1895.....	38	41	40	44	48	48	50	50	51	48	42	39	38
1896.....	40	44	33	41	45	47	50	52	52	47	38	42	33
1897.....	40	38	39	45	47	48	47	49	50	48	44	39	38
1898.....	36	43	40	44	46	49	47	47	50	50	43	38	36
1899.....	40	34	42	43	43	47	48	50	48	46	48	37	34
1900.....	42	44	43	45	47	47	48	50	47	48	45	40	40
1901.....	37	38	44	41	46	47	47	49	50	50	49	41	37
1902.....	38	40	41	44	47	48	47	52	51	49	45	39	38
1903.....	37	37	41	42	46	48	48	46	50	51	46	42	37
1904.....	40	40	40	44	45	48	50	49	49	52	49	38	38
1905.....	40	42	42	49	48	49	49	50	51	49	44	39	39
1906.....	41	46	41	43	42	48	49	50	48	47	40	40	40
1907.....	36	43	38	45	47	48	50	51	53	51	45	41	36
1908.....	40	40	40	45	46	46	48	50	50	47	44	35	35
1909.....	38	42	41	44	44	47	49	49	50	48	43	38	38
1910.....	36	38	44	46	48	48	48	48	48	47	44	43	36
1911.....	41	38	42	42	46	47	49	49	49	50	42	39	38
1912.....	40	44	43	44	46	48	49	50	52	48			

TABLE 4.—Mean hourly temperatures in degrees Fahrenheit, 1891–1910.

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1 a. m.....	48	50	50	51	52	53	53	54	56	56	53	49	50.2
2 a. m.....	47	49	50	50	52	52	53	54	56	55	53	48	51.7
3 a. m.....	47	49	49	50	51	52	53	54	56	55	52	48	51.4
4 a. m.....	47	48	49	50	51	52	53	54	56	55	52	48	51.2
5 a. m.....	47	48	49	50	51	52	53	54	56	55	52	48	51.3
6 a. m.....	46	48	49	50	51	52	53	54	55	55	52	47	50.9
7 a. m.....	46	48	49	50	52	54	54	54	56	55	52	47	51.4
8 a. m.....	46	48	50	52	54	56	55	56	57	56	52	47	52.4
9 a. m.....	47	49	51	54	56	58	57	57	59	57	53	48	53.8
10 a. m.....	48	50	52	56	57	60	59	59	61	59	54	49	55.4
11 a. m.....	49	52	54	57	59	61	60	60	63	61	56	50	56.8
12 noon.....	50	53	55	58	59	61	61	61	64	63	58	52	58.0
1 p. m.....	51	55	56	59	60	62	61	62	65	64	59	53	58.8
2 p. m.....	52	56	57	59	60	62	62	62	65	64	60	54	59.3
3 p. m.....	53	56	57	59	60	61	61	62	64	64	60	54	59.1
4 p. m.....	53	56	56	58	59	60	60	61	63	63	59	54	58.4
5 p. m.....	52	55	55	57	58	60	59	60	62	61	58	53	57.5
6 p. m.....	52	54	54	56	57	58	58	58	60	60	57	52	56.4
7 p. m.....	51	53	53	54	55	57	56	57	59	59	57	52	55.3
8 p. m.....	50	52	53	54	54	55	56	56	58	58	56	51	54.5
9 p. m.....	50	52	52	53	54	55	55	56	58	58	55	50	53.9
10 p. m.....	49	51	51	52	53	54	54	55	57	57	55	50	53.3
11 p. m.....	49	50	51	52	53	53	54	55	57	57	54	50	52.8
Midnight.....	48	50	50	51	52	53	54	54	56	56	54	49	52.4
Mean.....	49.2	51.3	52.1	53.8	55.7	56.3	56.0	57.0	59.1	58.5	55.2	50.2	54.6

NOTE ON EXPOSURE OF ANEMOMETERS AT SAN FRANCISCO.

The elevations of the anemometer above ground (street) have been as follows: January 1, 1891, to November 1, 1892, 109 feet; November 1, 1892, to April 18, 1906, 167 feet; May 1, 1906, to September 30, 1906, 42 feet; October 1, 1906, to September 31, 1910, 204 feet.

These elevations, however, can not be used without explanation concerning elevation of cups above the roof or nearest deck surface. Unfortunately most of the roofs occupied have had on them platforms or raised surfaces, and, as in the case of the Mills Building, the platform serving as a deck for Weather Bureau instruments was itself on top of an extra story 14 feet in height. This superstructure was 10 feet from the west wall of the building and about 30 feet from the south wall.

In the Mills Building and the Merchants Exchange are large interior courts, or light wells, which may have affected the results.

The approximate heights of the cups above the roof proper are: Merchants Exchange, October 1, 1906, to December 31, 1910, 18 feet; Mills Building, November 1, 1892, to April 18, 1906, 30 feet; Phelan Building, January 1, 1891, to November 1, 1892, 12 feet; No. 3014 Clay Street, May 1, 1906, to September 30, 1906, 4 feet.

TABLE 5.—Average hourly wind velocity in miles.

[Period, 1891-1910.]

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1 a. m.	6.4	6.3	7.2	7.4	8.6	9.5	10.0	9.5	7.6	6.5	5.6	5.9	7.5
2 a. m.	6.4	6.1	6.9	7.1	8.0	9.0	9.5	9.0	7.1	5.6	5.6	6.0	7.2
3 a. m.	6.4	5.8	6.8	6.7	7.4	8.3	8.8	8.2	6.7	5.4	5.6	6.0	6.8
4 a. m.	6.4	5.9	6.6	6.3	7.1	7.7	8.4	8.0	6.2	5.3	5.5	6.1	6.6
5 a. m.	6.5	5.9	6.6	6.3	7.0	7.4	8.0	7.7	6.0	5.1	5.5	6.2	6.5
6 a. m.	6.5	5.8	6.5	6.1	6.8	7.1	7.8	7.3	5.8	5.0	5.5	6.4	6.4
7 a. m.	6.7	5.9	6.4	7.3	6.8	7.0	7.8	7.2	5.8	5.0	5.5	6.5	6.5
8 a. m.	6.9	6.2	6.8	6.9	7.3	7.6	8.1	7.5	6.0	5.3	5.7	6.6	6.7
9 a. m.	7.2	6.7	7.3	7.6	7.8	8.1	8.4	7.8	6.5	5.6	5.9	6.9	7.2
10 a. m.	7.6	7.2	7.9	8.2	8.7	9.3	9.3	8.8	7.1	6.1	6.3	7.2	7.8
11 a. m.	7.8	7.4	8.4	9.2	10.4	11.4	11.2	10.5	8.3	6.5	6.5	7.3	8.8
12 noon	7.9	7.6	9.2	10.3	12.7	14.4	14.2	12.9	10.5	7.6	6.8	7.4	10.1
1 p. m.	8.2	8.3	10.6	13.2	15.0	16.9	16.9	15.7	12.9	9.5	7.3	7.7	11.8
2 p. m.	8.6	9.3	12.0	14.8	16.4	18.9	19.1	18.0	15.3	11.2	8.2	7.7	13.3
3 p. m.	8.5	10.1	13.2	15.7	17.5	20.0	20.6	19.6	16.7	12.6	8.9	7.7	14.3
4 p. m.	8.4	10.4	13.9	16.5	18.1	20.6	21.5	20.3	17.6	13.2	9.3	7.6	14.8
5 p. m.	8.1	10.4	13.6	16.6	18.1	20.8	21.8	20.5	17.8	13.7	9.6	7.2	14.8
6 p. m.	7.8	9.9	13.0	16.0	17.7	20.2	21.1	19.8	17.2	13.0	9.1	7.1	14.3
7 p. m.	7.6	9.3	11.9	14.6	16.1	18.7	19.5	18.2	15.2	11.2	8.2	6.5	13.1
8 p. m.	7.2	8.7	10.7	12.8	14.4	16.8	17.4	16.3	13.2	9.6	7.6	6.3	11.8
9 p. m.	7.0	7.8	9.4	11.0	12.7	14.7	15.3	14.3	11.5	8.5	6.9	6.2	10.4
10 p. m.	6.6	7.4	8.4	10.1	11.2	12.7	13.7	12.5	10.3	7.6	6.4	6.2	9.4
11 p. m.	6.3	6.9	7.9	9.1	10.1	11.4	12.2	11.3	9.1	6.8	6.1	6.1	8.6
12 midnight	6.3	6.4	7.4	8.1	9.2	10.2	11.0	10.2	8.2	6.3	5.8	6.0	7.9
Average...	7.2	7.6	9.1	10.3	11.5	12.9	13.4	12.5	10.3	8.0	6.8	6.7	9.7

TABLE 8.—San Francisco rainfall, monthly, seasonal, and annual, 1849-1912.

Season.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Seasonal.	Year.	Annual.
1849-50.....	0	0	0	3.14	8.66	6.20	8.34	1.77	4.53	0.46	0	0	33.10	1850	17.40
1850-51.....	0	0	0.33	0	0.92	1.05	0.72	0.54	1.94	1.23	0.67	0.02	7.42	1851	15.60
1851-52.....	0	0.02	1.03	0.21	0.12	1.05	0.58	0.14	6.08	0.26	0.32	0	18.46	1852	27.29
1852-53.....	0	0	0	0.80	5.31	13.20	3.92	1.42	4.86	5.37	0.38	0	35.26	1853	21.17
1853-54.....	0	0.04	0.46	0.12	2.28	2.32	3.88	8.04	3.51	3.12	0.02	0.08	23.87	1854	22.45
1854-55.....	0	0.01	0.15	2.43	0.34	0.87	3.67	4.77	4.64	5.00	1.88	0	23.76	1855	26.39
1855-56.....	0	0	0	0	0.67	5.76	9.40	0.50	1.60	2.94	0.76	0.03	21.66	1856	20.96
1856-57.....	0.02	0	0.07	0.45	2.79	3.75	2.45	8.59	1.62	0	0.05	0.12	19.91	1857	22.31
1857-58.....	0	0.05	0	0.43	3.01	4.14	4.36	1.83	5.55	1.55	0.34	0.05	21.81	1858	23.46
1858-59.....	0.05	0	0	2.74	7.28	6.14	1.28	6.32	3.62	0.27	1.55	0	22.22	1859	21.39
1859-60.....	0	0.02	0.03	0.65	0.58	1.57	1.04	1.60	3.99	3.51	2.86	0.09	22.77	1860	21.18
1860-61.....	0.21	0	0	0.91	0.16	6.16	2.47	3.72	4.08	0.73	1.00	0.08	19.72	1861	25.62
1861-62.....	0	0	0.02	0	4.10	9.54	24.36	7.53	2.20	0.54	0.74	0.03	49.27	1862	38.63
1862-63.....	0	0	0	0.52	0.15	2.35	3.63	3.19	2.06	1.61	0.78	0	13.74	1863	15.10
1863-64.....	0	0	0.03	0	2.55	1.80	1.83	1.34	1.32	1.57	0.78	0	10.08	1864	12.64
1864-65.....	0	0.21	0.04	0.13	0.68	8.91	5.14	0	3.04	0.94	0.63	0.04	24.73	1865	14.06
1865-66.....	0	0	0.24	0.26	4.19	0.58	5.16	7.20	3.04	2.36	1.46	0	22.93	1866	36.28
1866-67.....	0	0	0.11	0.35	3.35	15.16	9.50	6.13	6.30	2.31	0.03	0.23	34.92	1867	30.64
1867-68.....	0	0	0.04	0.20	3.41	10.69	6.35	3.90	3.14	2.19	0.08	0.02	38.84	1868	30.17
1868-69.....	0	0	0	0.15	1.18	4.34	3.38	4.78	2.00	1.53	0.20	0	19.31	1869	22.59
1869-70.....	0	0	0.12	1.29	1.19	4.31	3.89	3.76	2.00	1.89	0.18	0.01	14.11	1871	16.24
1870-71.....	0	0.02	0.03	0	0.43	3.38	3.07	3.60	1.59	0.81	0.18	0.04	30.78	1872	27.53
1871-72.....	0	0	0.04	0.07	2.81	14.36	4.00	6.90	1.59	0.43	0	0.02	15.66	1873	18.55
1872-73.....	0.01	0.08	0	0.11	2.79	5.95	1.58	3.94	3.36	0.90	0.66	0.14	24.73	1874	22.52
1873-74.....	0	0	0.83	0.83	1.16	9.72	5.66	2.21	3.36	0.70	0.22	1.02	20.56	1875	22.63
1874-75.....	0	0	0.02	2.69	6.55	0.33	8.01	0.32	5.49	1.29	0.24	0.04	31.19	1876	23.54
1875-76.....	0	0	0	0.24	7.27	4.15	7.55	4.92	1.08	0.26	0.18	0.01	11.04	1877	11.93
1876-77.....	0.01	0.01	0.38	3.36	0.25	2.66	11.97	12.52	4.50	1.06	0.16	0.01	35.18	1878	33.36
1877-78.....	0.02	0	0.65	1.57	1.57	0.58	3.52	4.90	8.75	1.89	2.35	0.05	24.44	1879	30.76
1878-79.....	0.01	T.	0	1.27	4.03	12.33	2.23	1.87	2.08	10.06	1.12	0	26.66	1880	30.07
1879-80.....	0.01	0.02	0.55	0.78	0.33	4.46	8.69	4.65	0.90	2.00	0.22	0.69	29.86	1881	23.73
1880-81.....	0	0	0	0.66	0.33	3.85	1.68	2.96	3.45	1.22	0.21	0.04	16.14	1882	18.67
1881-82.....	0	0	0.25	0.54	1.94	3.85	1.92	1.04	3.01	1.51	3.52	0.01	20.12	1883	15.43
1882-83.....	0	0	0.26	4.18	0.60	2.01	3.94	6.30	8.24	6.33	0.23	2.57	32.38	1884	38.82
1883-84.....	0	0	0.42	1.48	1.60	7.08	2.53	0.30	1.01	3.17	0.04	0.19	18.10	1885	24.90
1884-85.....	0.04	T.	0.33	2.55	1.22	4.99	7.42	0.24	2.07	5.28	0.37	0.01	33.05	1886	20.02
1885-86.....	0	0	0.72	11.78	0.84	4.99	1.90	9.24	0.84	2.30	0.06	0.07	19.04	1887	19.04
1886-87.....	0.06	T.	0.11	1.48	0.99	2.07	6.81	0.94	3.60	0.34	0.38	0.27	16.74	1888	23.03
1887-88.....	0.23	T.	0.01	T.	0.99	5.80	1.28	0.72	3.60	0.96	2.17	0.03	23.86	1889	36.94
1888-89.....	0.01	0.01	0.98	0.13	2.90	13.81	9.61	5.16	4.73	1.18	1.07	0.10	45.85	1890	25.43
1889-90.....	0.01	T.	0	7.28	0	3.25	0.98	7.26	1.90	2.44	1.25	0.11	17.58	1891	21.11
1890-91.....	0	0	0.31	0	0.56	5.62	2.42	2.75	1.96	2.44	1.86	T.	18.53	1892	22.08
1891-92.....	0.10	0.02	0.77	0.04	0	5.08	3.05	2.75	4.08	1.39	1.03	0.03	18.93	1893	17.91
1892-93.....	0	0	0.02	1.65	3.91	0	5.99	2.69	4.08	0.50	1.31	0.56	21.75	1894	17.91
1893-94.....	0.02	0	0.21	0.16	4.18	2.25	5.99	2.69	0.00	0.50	1.31	0.56	18.47	1894	24.32

TABLE 8.—*San Francisco rainfall, monthly, seasonal, and annual, 1849-1912—Continued.*

Season.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Seasonal.	Year.	Annual.
1894-95.....	T.	0	1.05	1.73	0.88	9.01	6.99	2.31	1.89	1.24	0.60	0	25.70	1895	17.13
1895-96.....	0.01	0	0.77	0.11	1.78	1.43	8.14	0.28	2.85	5.16	0.72	0	21.25	1896	28.25
1896-97.....	0.04	0.09	0.52	1.55	4.56	4.34	2.26	4.41	4.56	0.27	0.61	0.22	23.43	1897	16.40
1897-98.....	T.	T.	0.10	1.70	1.05	1.22	1.12	2.13	0.24	0.19	1.44	0.19	9.38	1898	9.31
1898-99.....	0	T.	1.06	0.86	0.46	1.62	3.67	0.10	7.61	0.62	0.86	0.01	16.87	1899	23.23
1899-1900.....	0	T.	0	3.92	3.79	2.65	4.11	0.64	1.91	1.08	0.32	0.05	18.47	1900	15.33
1900-1901.....	T.	T.	0.46	1.48	3.91	1.37	5.79	5.03	0.80	1.64	0.69	T.	21.17	1901	19.75
1901-2.....	T.	T.	0.78	0.64	3.48	0.90	1.23	7.27	2.65	0.98	1.05	0	18.98	1902	19.18
1902-3.....	T.	T.	T.	1.70	1.98	2.32	3.73	1.76	6.23	0.56	T.	T.	18.28	1903	18.33
1903-4.....	0	T.	T.	0.17	4.25	1.63	1.65	5.89	6.01	1.29	0.30	T.	20.59	1904	24.72
1904-5.....	0.02	0.06	5.07	2.37	1.07	1.59	4.04	2.70	3.15	1.33	2.65	0	23.45	1905	16.24
1905-6.....	0	T.	T.	T.	0.92	2.05	3.90	4.30	5.02	0.92	2.75	0.56	20.42	1906	26.34
1906-7.....	0.08	0.11	0.18	0.03	1.59	6.90	4.41	3.02	8.42	0.11	0.04	1.28	26.17	1907	22.47
1907-8.....	T.	0.02	0.11	1.36	0.04	3.66	4.88	5.39	0.90	T.	0.76	0.01	17.35	1908	16.42
1908-9.....	0.02	0.01	0.13	0.61	1.31	2.15	10.51	7.53	3.27	T.	T.	T.	25.57	1909	31.36
1909-10.....	0	T.	0.80	1.23	2.43	5.59	3.24	2.09	3.78	0.31	0.63	0.02	19.52	1910	12.38
1910-11.....	T.	0	0.65	0.65	0.48	1.73	13.79	3.02	4.57	0.89	0.28	0.03	25.49	1911	26.00
1911-12.....	T.	0	T.	0.28	0.60	2.54	2.47	0.41	4.10	1.38	1.47	0.81	14.06	1912	15.62
1912-.....	T.	0	1.25	0.49	1.94	1.30	.....	.....	.....	.....	.....	.....	.....	.....	.....
Averages.....	0.02	0.02	0.32	1.00	2.55	4.51	4.90	3.55	3.36	1.64	0.73	0.16	22.58	.....	22.60

TABLE 9.—*Greatest precipitation (inches and hundredths) in twenty-four hours for each month.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Greatest annual.
1871.....			0.57	1.28	0.13	0.01	0.00	0.02	0.00	0.07	1.24	3.14	3.14
1872.....	2.36	1.28	0.73	0.35	0.15	0.03	0.01	0.00	0.04	0.11	2.06	2.33	2.36
1873.....	1.02	0.82	0.54	0.36	0.00	0.01	0.01	0.05	0.00	0.77	0.80	2.33	2.33
1874.....	1.61	0.81	0.65	0.70	0.23	0.13	0.00	0.00	0.02	1.58	3.98	0.15	3.98
1875.....	2.19	0.27	0.45	0.06	0.14	0.90	0.00	0.00	0.00	0.22	2.37	1.50	2.37
1876.....	1.76	1.80	1.59	0.60	0.24	0.04	0.01	0.01	0.20	1.39	0.19	0.00	1.80
1877.....	1.63	0.52	0.56	0.08	0.18	0.01	0.02	0.00	0.00	0.36	0.56	1.11	1.63
1878.....	1.98	1.92	1.01	0.61	0.14	0.01	0.01	T.	0.45	1.27	0.45	0.33	1.98
1879.....	1.04	1.66	3.31	0.72	0.93	0.05	0.01	0.02	T.	0.56	1.38	1.55	3.31
1880.....	1.03	0.64	0.57	2.21	0.84	0.00	0.00	0.00	0.00	0.05	0.32	2.36	2.36
1881.....	4.67	1.37	0.69	1.09	0.17	0.41	0.00	0.00	0.25	0.21	1.34	1.35	4.67
1882.....	0.57	0.82	0.86	0.44	0.15	0.02	0.00	0.00	0.26	1.49	2.41	0.76	2.41
1883.....	1.30	0.71	1.63	0.76	1.23	0.01	0.00	0.00	0.42	1.19	1.01	0.28	1.63
1884.....	1.44	1.62	2.21	1.66	0.12	1.23	0.00	0.03	0.21	1.15	0.19	2.07	2.21
1885.....	0.97	0.15	0.55	2.03	0.04	0.10	0.05	T.	0.11	0.70	2.58	2.78	2.78
1886.....	2.40	0.18	0.65	1.36	0.21	0.01	0.23	0.00	0.01	0.72	0.77	1.10	2.40
1887.....	0.80	3.60	0.52	1.45	0.03	0.07	T.	0.01	0.18	0.00	0.48	1.14	3.60
1888.....	1.58	0.38	1.34	0.11	0.19	0.10	0.01	0.01	0.92	0.05	1.68	1.51	1.68
1889.....	0.81	0.59	3.08	0.30	1.29	0.03	0.01	T.	T.	2.03	0.92	1.46	3.08
1890.....	2.08	1.63	1.86	0.55	0.53	0.05	0.02	0.00	0.31	0.00	0.00	1.90	2.08
1891.....	0.75	3.38	0.68	1.20	0.61	0.10	0.09	0.02	0.63	0.03	0.26	2.21	3.38
1892.....	1.06	1.03	0.90	0.38	1.15	T.	0.00	0.00	0.02	0.91	1.46	2.34	2.34
1893.....	1.39	1.06	0.98	0.71	0.14	0.03	0.02	0.00	0.12	0.10	1.69	0.97	1.69
1894.....	2.61	1.05	0.34	0.30	0.68	0.22	T.	0.00	1.04	0.64	0.88	1.64	2.61
1895.....	1.96	1.44	0.67	0.89	0.27	0.00	0.01	0.00	0.62	0.06	1.06	0.51	1.96
1896.....	1.85	0.18	0.84	2.43	0.34	0.00	0.04	0.06	0.41	1.46	2.79	1.65	2.79
1897.....	1.08	1.23	1.42	0.20	0.61	0.19	T.	T.	0.08	1.41	0.42	1.02	1.42
1898.....	0.33	0.78	0.13	0.19	1.23	0.18	0.09	T.	0.73	0.45	0.36	0.70	1.23
1899.....	0.98	0.08	2.15	0.45	0.77	0.01	0.00	T.	0.00	1.94	1.51	1.17	2.15
1900.....	1.92	0.50	0.90	0.36	0.22	0.04	T.	T.	0.45	0.34	1.66	0.74	1.92
1901.....	1.75	1.95	0.67	0.88	0.46	T.	T.	T.	0.67	0.43	1.20	0.01	1.95
1902.....	0.35	1.08	0.69	0.23	0.56	0.00	T.	T.	T.	0.69	0.77	0.85	2.08
1903.....	1.00	0.63	1.30	0.39	T.	T.	0.00	T.	T.	0.15	2.39	1.06	2.39
1904.....	0.59	2.73	1.32	0.40	0.30	T.	0.02	0.05	3.58	0.72	0.56	0.57	3.58
1905.....	1.08	1.23	0.93	0.49	1.18	0.00	0.00	T.	T.	T.	0.38	0.65	1.23
1906.....	1.06	1.32	1.37	0.51	1.42	0.23	0.05	0.08	0.12	0.01	0.67	2.57	2.47
1907.....	0.91	1.52	1.82	0.08	0.02	0.74	T.	0.02	0.11	0.99	0.02	0.96	1.82
1908.....	2.10	2.04	1.41	0.10	0.24	0.01	0.02	0.01	0.10	0.44	0.70	0.99	2.10
1909.....	1.61	1.87	1.16	T.	T.	T.	T.	0.00	0.67	0.82	0.97	1.41	1.87
1910.....	0.83	0.64	1.17	0.23	0.02	0.02	T.	0.00	0.04	0.48	0.27	0.99	1.17
1911.....	2.48	0.68	1.98	0.81	0.15	0.03	T.	0.00	T.	0.16	0.45	0.66	2.48
1912.....	1.05	0.19	2.09	0.80	0.74	0.68	T.	0.00	1.21	.....	.....	.....	.....
Year.....	4.67	3.60	3.31	2.43	1.42	1.23	0.23	0.08	3.58	2.03	3.98	3.14	4.67

Dates when the precipitation equaled or exceeded 2.50 inches in any consecutive 24 hours: 1871, December 17–18, 2.83 inches; 1871, December 18–19, 3.14 inches; 1874, November 22–23, 3.98 inches; 1879, March 4–5, 3.31 inches; 1881, January 28–29, 4.67 inches; 1885, November 23–24, 2.58 inches; 1885, December 21, 2.78 inches; 1887, February 4–5, 3.60 inches; 1889, March 12–13, 3.08 inches; 1891, February 14–15, 3.38 inches; 1894, January 19–20, 2.61 inches; 1896, November 23–24, 2.79 inches; 1904, February 11–12, 2.73 inches; 1904, September 23, 3.58 inches.

Maximum rates of rainfall: 1901, February 22, 5 minutes, 0.17 of an inch; 10 minutes, 0.21; 1902, October 23, 5 minutes, 0.16 of an inch; 10 minutes, 0.20; 1903, February 7, 5 minutes, 0.19 of an inch; 10 minutes, 0.23; 1904, September 23, 5 minutes, 0.16 of an inch; 10 minutes, 0.32; 1904, September 23, in 15 minutes, 0.43; in 30 minutes, 0.74; in 1 hour, 0.97; in 2 hours, 1.29; in 16 hours 15 minutes, 3.58 inches; 1912, March 5, 5 minutes, 0.10; 10 minutes, 0.28; 15 minutes, 0.53; 20 minutes, 0.72; 25 minutes, 0.77; and 30 minutes, 0.78 of an inch.

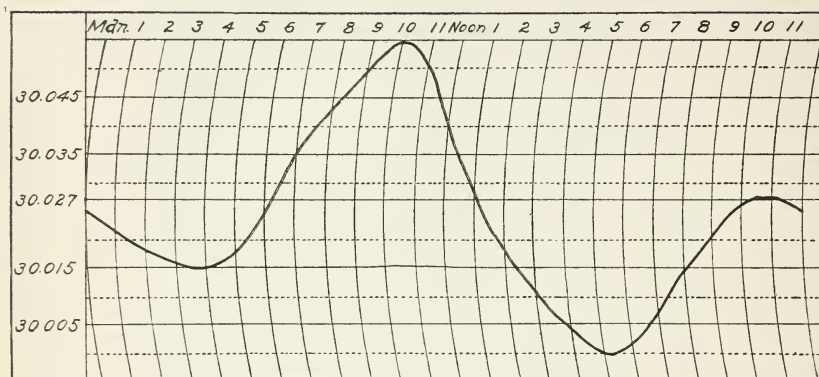


FIG. 1.—Hourly pressure, San Francisco. (Sea level).

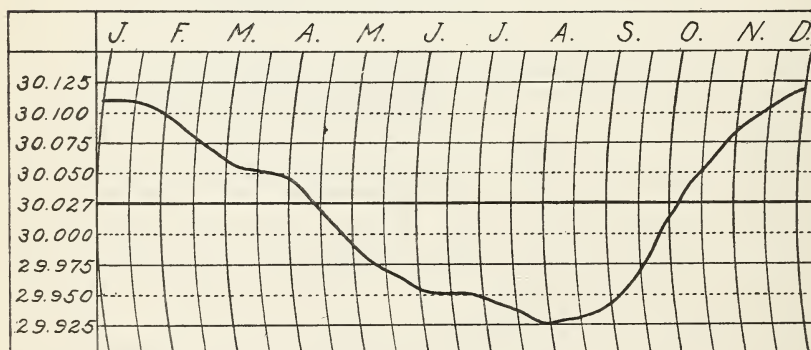


FIG. 2.—Monthly sea level pressure, San Francisco.

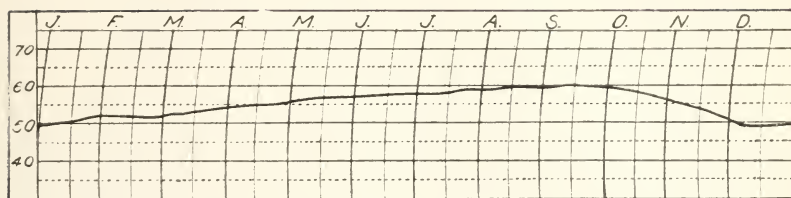


FIG. 3.—Mean monthly temperature at San Francisco, 1891-1910.

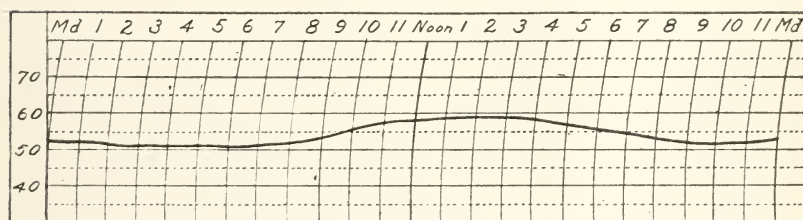


FIG. 4.—Average hourly temperature at San Francisco, 1891-1910.

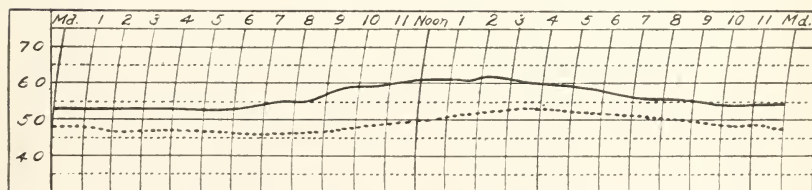


FIG. 5.—Mean hourly temperature—Summer ———, winter

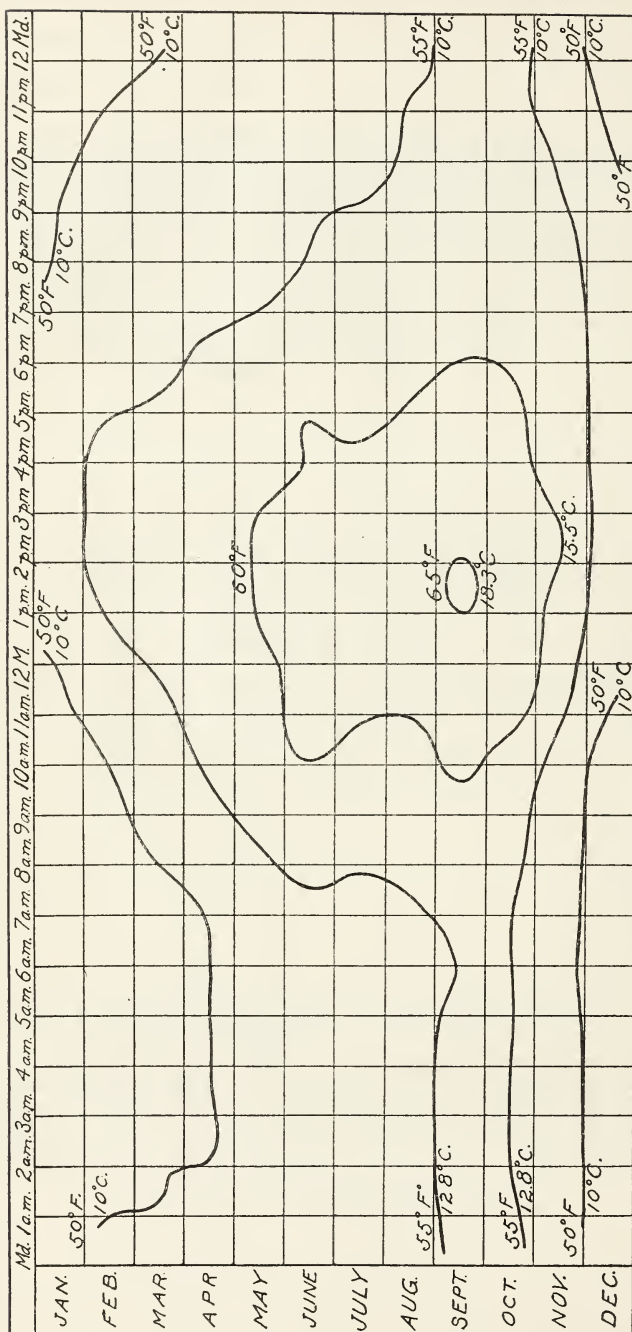


FIG. 6.—Isopleth of temperature at San Francisco, 1891-1910.

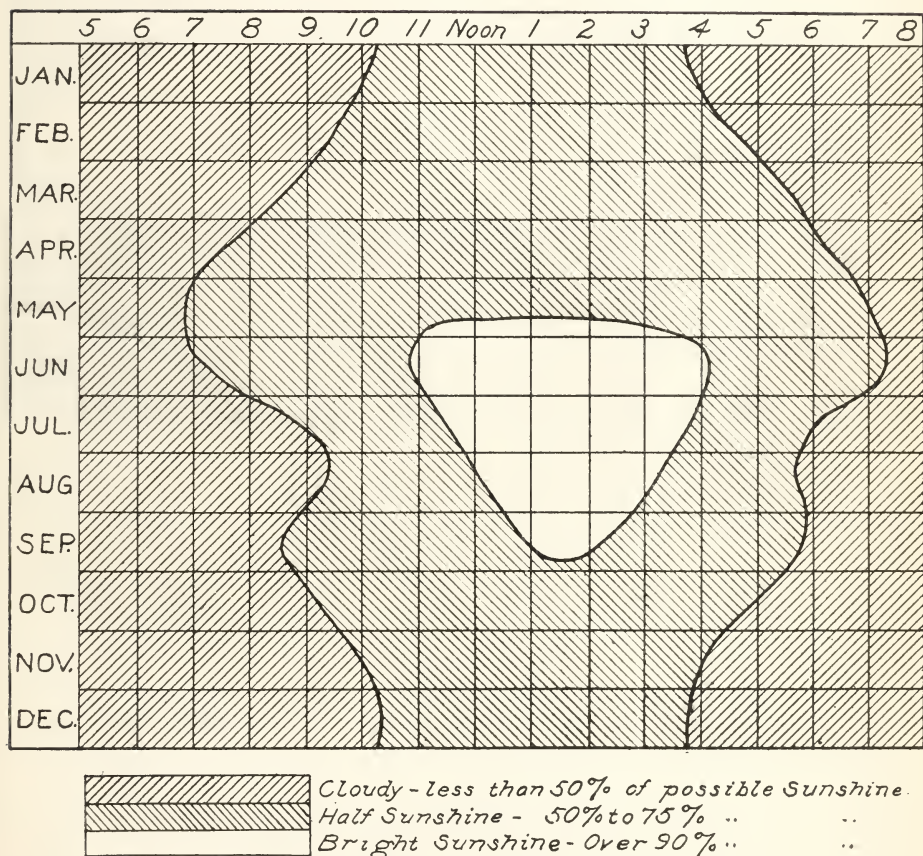


FIG. 7.—Sunshine at San Francisco, 1893-1911.

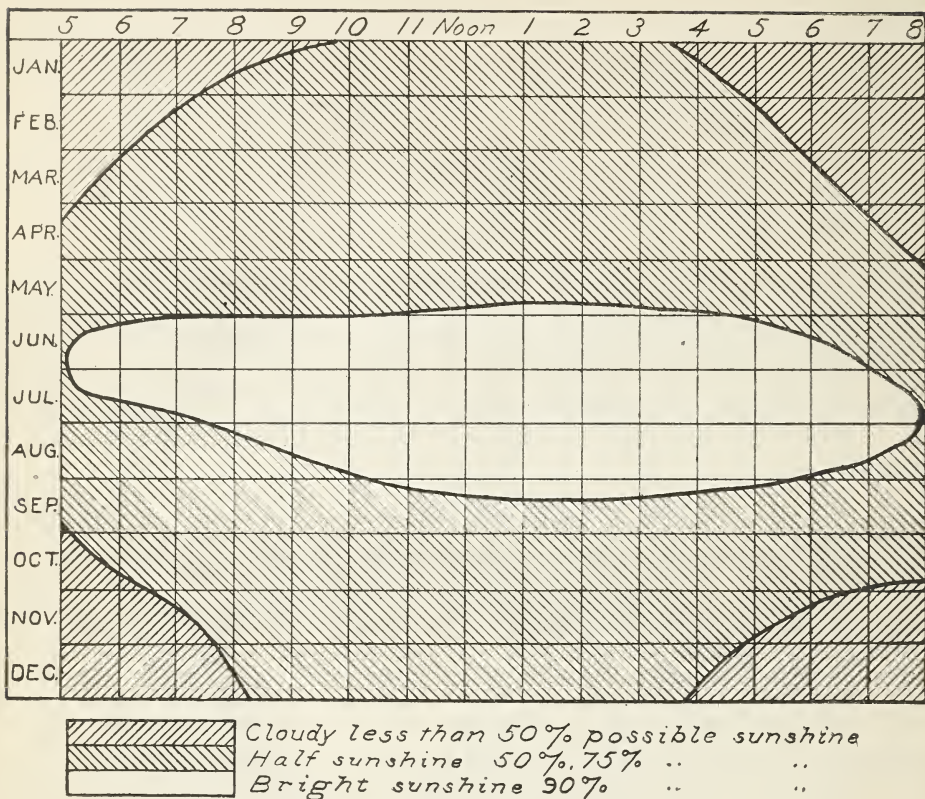


FIG. 8.—Sunshine at Mount Tamalpais, 1890-1911.

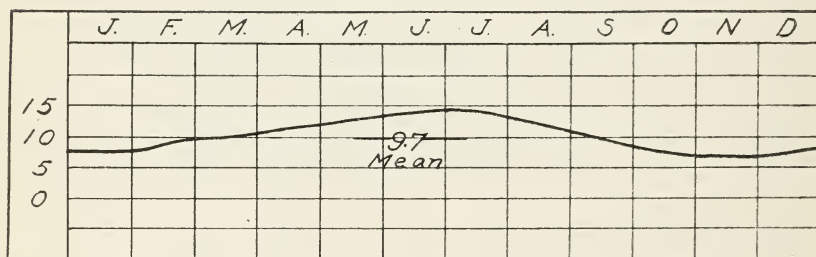


FIG. 9.—Average monthly wind velocity, 1891-1910.

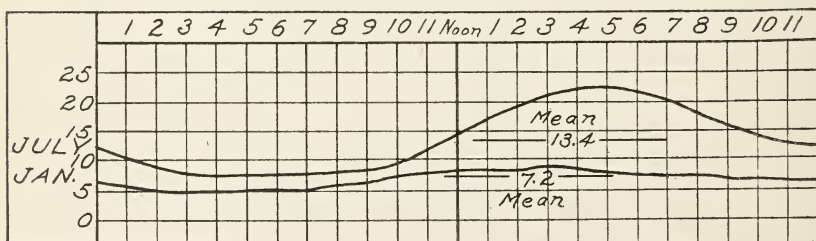


FIG. 10.—Hourly wind velocity, 1891-1910.

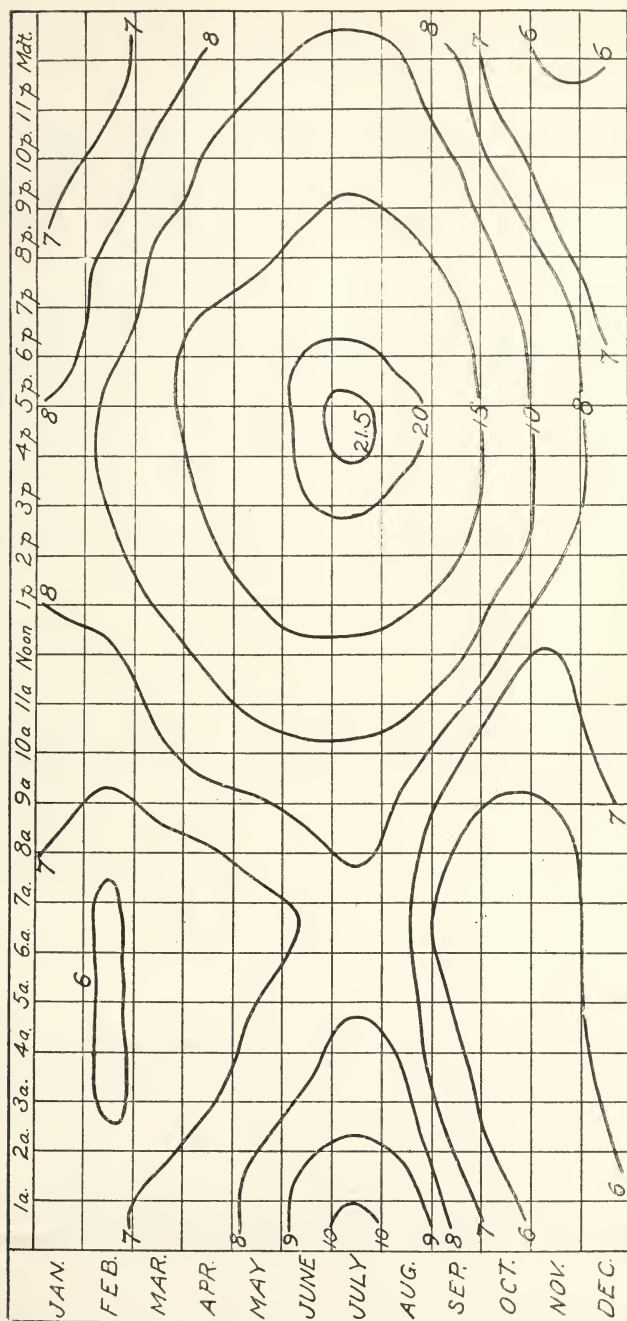


FIG. 11.—Isopleth of wind, San Francisco, 1891-1910.

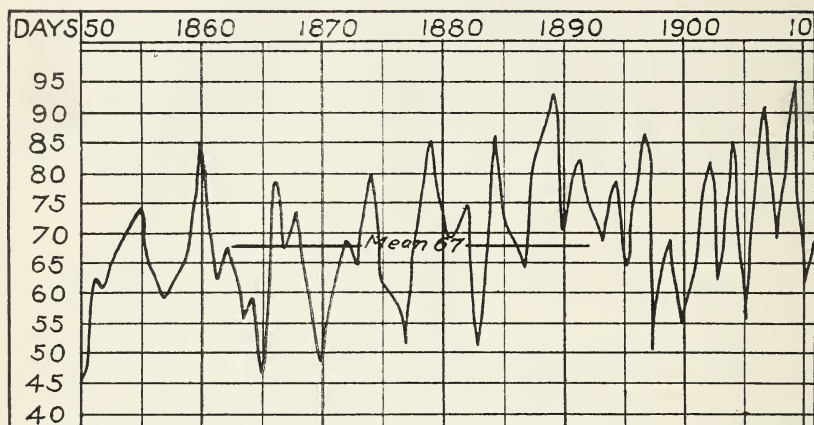


FIG. 12.—Annual frequency of rainy days, San Francisco.

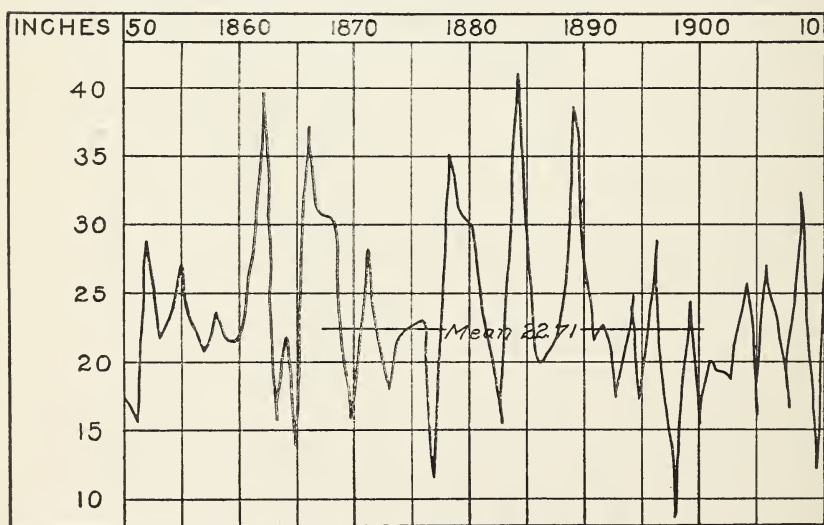


FIG. 13.—Annual rainfall at San Francisco, 1850-1911.

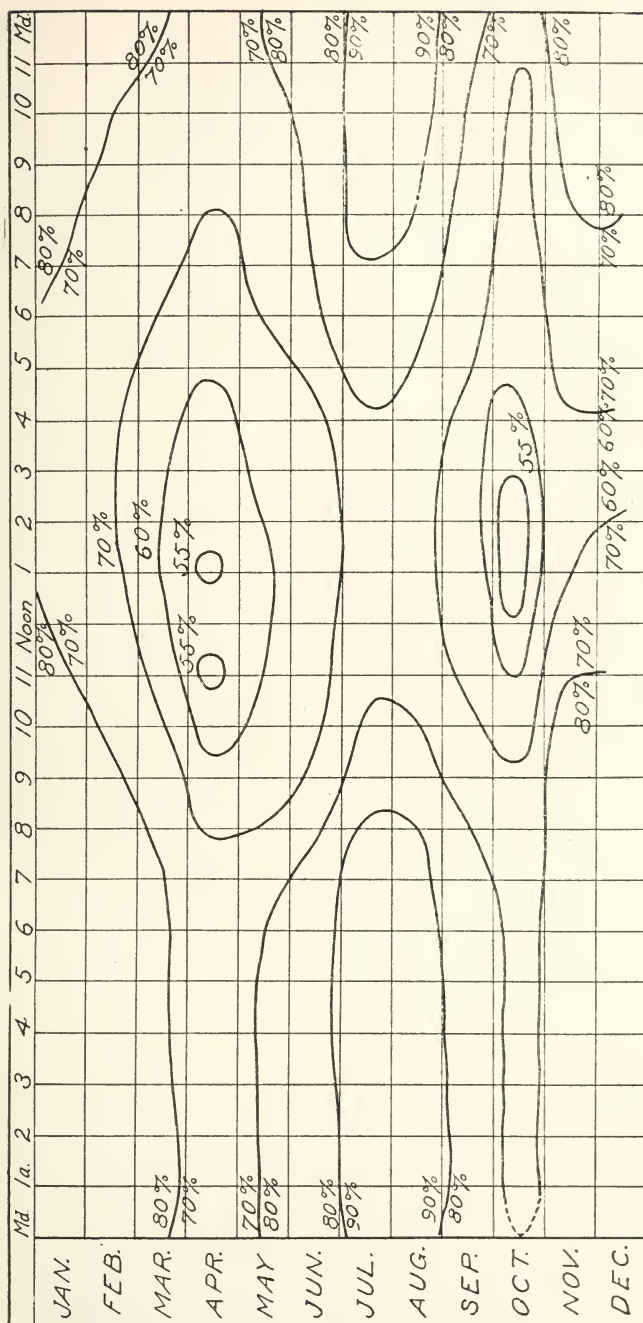


FIG. 14.—Isopleth of relative humidity, 1908-1909, San Francisco.

